

LESSON 8: Separation Mania

LESSON'S CONCEPT

Waste can be sorted by physical properties, and some waste materials can be recycled.

PURPOSE

Students identify ways waste items are sorted for recycling at a materials recovery facility.

OVERVIEW

Note: In this lesson “older students” refers to students in fifth and sixth grades; “younger students” refers to students in fourth grade.

In this lesson younger students will:

- Identify specific properties of recyclable items by determining which items sink or float, are magnetic, can be moved by wind, or can be easily cut or shredded.
- Compare different characteristics of recyclable materials.
- Determine ways to sort recyclable materials.

In this lesson older students will:

- Use several mechanisms to separate ten different recyclable waste items and record the results on a data sheet.
- Identify specific properties of recyclable items by determining which items sink or float, are magnetic, can be moved by wind, or can be easily cut or shredded.
- Recognize that the techniques they used to separate certain recyclable items are similar to the ways used to separate recyclables at a materials recovery facility.
- Work in groups to develop an efficient design for the separation process, based on the data they have gathered on their data sheets.

All students participate in manually separating recyclables on a simulated conveyor belt to show how a materials recovery facility works.

CORRELATIONS TO CALIFORNIA'S CONTENT STANDARDS

- Students collect data about properties of recyclable materials.

- Students “classify objects . . . based on appropriate criteria.” (*Science Content Standards, Grades K–12; Grade 5; Investigation and Experimentation, Standard 6a*)
- Students “record data using appropriate graphical representation (including charts, graphs, and labeled diagrams), and make inferences based on those data.” (*Science Content Standards, Grades K–12; Grade 5; Investigation and Experimentation, Standard 6g*)
- “Students organize, represent, and interpret numerical and categorical data and clearly communicate their findings.” (*Mathematics Content Standards for California Public Schools, Kindergarten Through Grade Twelve, page 18*)
- Students work in groups to develop methods to separate recyclables.
 - Students “measure and estimate weight, length, or volume of objects.” (*Science Content Standards, Grades K–12; Grade 4; Investigation and Experimentation, Standard 6b*)

SCIENTIFIC THINKING PROCESSES

observing, communicating, ordering, classifying, relating

TIME

30–60 minutes to prepare for the lesson; 90 minutes to implement the lesson (If working with younger students and setting up one station per day, it will take five days at 30–45 minutes per day to complete Part I.)

VOCABULARY

materials recovery facility, properties

PREPARATION

- 1. Read the “Background Information for the Teacher” at the end of this lesson.

For “Pre-Activity Questions”

- Several pieces of assorted trash

For younger students

See “Procedure, Part I” and decide on “Option 1” or “Option 2.” If you select “Option 1,” only one station needs to be set up each day, and only one set of trash items will be needed. If you select “Option 2,” set up all five stations.

- 2. At each station leave six trash items listed in the “Materials” section and the corresponding “Activity Cards for the Stations” (page 406). Provide the tools needed for each station:
 - **Size Station:** a ruler
 - **Weigh Station:** a weight scale or balance beam
 - **Magnetism Station:** magnets
 - **Sinkers and Floaters Station:** a container of water
 - **Shredding Station:** scissors
(This station may need an adult supervisor.)
- 3. Make copies of the “Sorting Sheet” for each pair of students (pages 407 and 408). Consider laminating these sheets and having students use pens with wipeable ink to complete the chart. Then these sheets can be reused by other classes.
- 4. Make a transparency of “Properties of Recyclable Items” (page 409) and the “Sorting Sheet.”

For older students

- Duplicate “Properties of Recyclable Items.”

MATERIALS

- Optional: The video, “The Rotten Truth”

For “Part I, Using Separation Techniques to Separate Recyclables”

For younger students

- Ruler
- Weight scale (or balance beams)
- Scissors
- A magnet (preferably a bar magnet attached to a flat piece of wood)

- A small fan with two speeds or a hair dryer with two speeds (If not available, a heavy piece of cardboard can be used as a fan.)
- An aquarium tank or other large container for water
- One set of the following six items if doing “Option 1” and five sets of the following six items if doing “Option 2” (Substitutes for any of the objects can be used if they are easier to obtain.)
 - Aluminum can
 - Soup can
 - Piece of paper (8½ by 11 inches)
 - Plastic 2-liter soda bottle
 - Piece of polystyrene (Styrofoam)
 - Orange or banana peel
- A copy of “Activity Cards for the Stations,” cut apart
- A copy of the “Sorting Sheet” for each pair of students
- A transparency of “Properties of Recyclable Items”

For older students

- Weight scale (or balance beams)
- A transparency of “Properties of Recyclable Items”

For each group of older students

- A set of the following ten trash items: aluminum can, tin can, plastic 2-liter bottle, polystyrene (Styrofoam) container, an orange or banana peel, several used or unused staples, piece of paper (8½ by 11 inches), pieces of cardboard, piece of wood, and a steel bottle cap (Have extra pieces of paper or cardboard on hand.)
- Ruler
- Scissors
- A magnet (preferably a bar magnet attached to a flat piece of wood)
- A small fan with two speeds or a hair dryer with two speeds (If not available, a heavy piece of cardboard can be used as a fan.)
- A plastic pan or other large container for water
- A copy of “Properties of Recyclable Items”

Note: To reduce the number of materials needed for this lesson, one station can be set up for each test. Groups can rotate from one station to another to test their trash items.

For “Part II, Separating the Recyclables Manually”

- Long sheet of butcher paper (approximately 10 feet to 15 feet long)
- Several cardboard boxes (Label each box by a specific recyclable material [e.g., aluminum, containers from #1 plastic, paper].)
- Waste items from “Part I” and clean waste from the class garbage can to represent recyclable and nonrecyclable materials

PRE-ACTIVITY QUESTIONS

- A. Begin with the following discussion:
- “Has anyone ever seen the inside of a materials recovery facility, also called a MRF (pronounced “Merf”)? A materials recovery facility is usually a huge building where all the recyclables from local communities are taken and separated by machines and by people. Then the recyclables are trucked to be recycled. We will be setting up a small materials recovery facility in our classroom. In order to learn how a materials recovery facility works, you need to learn about the properties of recyclables.”
- B. Have students sit in a circle, and place several recyclable items in the middle. Ask the following questions:
- How could we separate these items, based on their properties? *By using magnets, by looking at them.*
 - What are the differences among the dif-

ferent materials? *Some are plastic; some, aluminum.*

- What are some properties of these items that will allow us to separate them? *Heavy, light, magnetic or not, sinkers, floaters, shredable (easy to cut or not).*

- C. Make a class list of different properties of the recyclable items.

PROCEDURE

Part I, Using Separation Techniques to Separate Recyclables

Note: If the video is available, show Part 2, “Where Does It Go?” from *The Rotten Truth*.

For younger students

- A. Tell students that in this activity they will learn more about the properties of recyclable items. They will also simulate what happens at a materials recovery facility.

Students will explore one property at a time.

- B. If you are setting up one station for each of five days, do “Option 1.” If you are setting up rotation stations (if this activity will be done in one day), do “Option 2.” As a class, go over the sorting sheet and have students predict the results. Write these on the transparency, “Sorting Sheet.”



Davis Street SMaRT (Station for Material Recycling and Transfer), San Leandro, California.

Option 1

If only one station per day is set up:

- As a class, go over the station's directions and ask students to predict the results as you write these in the proper station on the "Sorting Sheet" transparency.
- Set up one station by providing an activity card with directions and the tool described in the activity card.
- Provide a set of six objects and allow one pair of students to visit the center, while the rest of the class works on another assignment.
- Tell students that they will be testing six items at the station.
- Provide a "Sorting Sheet" for each pair of students and ask them to complete the section that corresponds to the center (e.g., size station).
- As a class, complete the appropriate section on the transparency, "Properties of Recyclable Items."

Option 2

If the rotation method is used:

- At each station, leave six items listed in the "Materials" section, an activity card with directions, and the tool (e.g., ruler) described in the activity card.

- As a class, go over each station's directions and ask students to predict the results as you write these in the proper station on the "Sorting Sheet" transparency.
- Separate the class into five groups.
- Tell students that they will be testing six items at every station for specific properties. Each group will rotate from one station to another.
- Provide a "Sorting Sheet" for each pair of students.
- Model possible explorations at each station before starting group rotations.
- Give each group a reasonable time (about five to ten minutes) to explore each station; then rotate each group to the next station.
- Allow the last group at each station to share its findings with the class.
- Have students compare their findings to their predictions.
- Complete numbers 1 through 6 on the chart, "Properties of Recyclable Items," as a class.

The stations are:

- **Size Station:** Students sort six objects from largest to smallest. Have rulers available.

Picture intentionally deleted.

A group of students from Janet Cohen's sixth-grade class at Gold Trail Elementary School look at the waste items they received before testing the properties of each item.

- **Weigh Station:** Students sort six materials from heaviest to lightest, using a weight scale or balance beam.
 - **Magnetism Station:** Students explore which six items are magnetic.
 - **Sinkers and Floaters Station:** Students test six items to see whether each sinks or floats. Have a container of water available.
 - **Shredding Station:** Students try to cut six different items. Have scissors available. (This station may need an adult supervisor.)
- C. Lead students in a debriefing of what they found out at each station. Help students make a graph of the results.
- D. Explain to students that they are simulating some machines that separate materials at a materials recovery facility. In “Part II” they will simulate how workers at some materials recovery facilities separate materials.

For older students

Students will work in groups to test the properties of ten waste items.

- A. Tell students that in this activity they will learn more about the properties of recyclable items. They will also simulate what happens at a materials recovery facility.
- B. Discuss the concept of properties of matter; e.g., size, shape, weight, magnetism.
- Discuss the importance of sorting waste according to the type of material from which the waste was made before it can be recycled.
 - Show students the pieces of paper and staples.
 - Explain how these often end up together at paper recycling plants and can be separated, based on the physical property of magnetism in staples.
- C. Divide the class into small groups. Give each group a set of ten waste items listed in the “Materials” section. Discuss some physical properties of these items.
- D. As a class, go over each station’s directions and ask students to predict the results as you write these in the proper station on the “Sorting Sheet” transparency. Another way to do this is to provide the “Sorting Sheet” to each group of students and ask them to
- write their predictions for each station in their journals.
- E. Distribute a copy of the handout, “Properties of Recyclable Items,” to each group of students, and have the group complete it. Students will need to test the items in various ways in order to make choices on the handout. For this, provide to each group rulers, a container of water, a magnet, and scissors.
- Note:** Each test could also be set up as a station. Groups can rotate from one station to another to test their trash items.
- F. After the charts have been completed, discuss the answers and have students compare their findings to their predictions.
- G. Tell students that they will design a mechanized materials recovery facility. In Part II of this lesson, they will experience a manual way to separate waste. Display on a large table a magnet, a small fan or hair dryer, a container of water, and scissors. Instruct students to use the information on the handout and the equipment to develop a process for separating all ten items individually. Tell students:
- Do this by designing separation techniques in a series of stages. You must begin with all ten items in one pile bunched up close together on the table.
 - Since this is a mechanized materials recovery facility, you can pick up items only with a separation instrument or technique. You cannot use your fingers to pick up items.
 - The goal of each group is to separate the items most efficiently; i.e., in the fewest steps or with the most success.
- H. Demonstrate this process (as described below) for students to give them ideas, but encourage students to participate in the thinking process of this separation.
- Ask students to look at their information sheets and predict which items should float and which will not.
 - Put all ten items in the water.
 - Put those items that floated on the table in a separate bunch from those which did not float. This represents the first stage or step to be counted in the process.

Picture intentionally deleted.

Students from Nona Reimer's fifth-grade class at John Malcom Elementary School test materials to see whether they sink or float.

- Explain this process. The next step(s) must involve sorting items from each of the two piles. Eventually, you want to separate each item individually. The individual separation of one item from the rest could happen in a first step or on the sixth step, depending on the material and the design of the separation techniques.
- Do another demonstration.
 - Use scissors to make a pile of shredded plastic (from the bottle) and of shredded paper.
 - The shredding process represents only one stage, although two types of materials have been shredded.
 - Use a hair drier or fan. A piece of heavy cardboard can be used as a fan. If a fan is used, set the fan on the table in front of the pieces of paper and plastic.
 - Put the cardboard box at the end of the table. Turn the fan on at a distance from the pieces and at a speed which

will blow only paper into the box (or perhaps only the plastic if the paper is wet from having been in the water).

- Now you have separated these two items in two steps, including the shredding process.
 - You have eight more items to separate.
- I. Explain that you have deduced this step, based on information about the weight of the materials listed on the handout. One important separating technique would be one that separates the items into three piles instead of two.
- J. Direct pairs or groups of students to look carefully at their information sheets and to design stages in a process to separate all of the materials.
- K. Have each pair or group of students conduct the separation steps and then present its findings to the class.
- L. The judgment about which is the "most efficient" could be put to the test by classmates for their observation and measurement. Which group had the fewest steps. Why might fewer steps be more desirable? *Yes. Why? It takes fewer machines, less time, and less energy and, therefore, would cost less.*

Part II, Separating the Recyclables Manually

In this activity students will simulate how workers separate materials at some materials recovery facilities.

- A. Have a group of students sit along both sides of a long sheet of butcher paper on the floor. This butcher paper represents a conveyor belt.
- Place several cardboard boxes next to students and label each box according to a specific recyclable material (e.g., aluminum, plastic #1 bottles, paper).
 - Spread recyclable and nonrecyclable waste on the paper.
- B. Assign certain students to pick out specific items, such as aluminum, plastic bottles, etc.
- C. When students are ready, slowly pull the paper as students pick off specific items. The goal is to pick off all recyclables, so that

only nonrecyclable materials that will be going to the landfill remain.

- D. Have students come up with ideas on how the piece of butcher paper used in this activity can be reused. *Use it to cover a bulletin board, cut to the size to make posters or murals for future lessons, use it for art projects.* You might also consider rolling it up and storing it until the class comes up with an idea that all students like.

DISCUSSION/QUESTIONS

- A. Discuss which method of separation is most efficient: curbside separation, separation by machines at a materials recovery facility, manual separation at a materials recovery facility. Which would be most energy-efficient? Explain why.
- B. Discuss which items are recycled in the community and which are not. Of the items recycled in the community, which could be separated by the methods we used in this lesson?

APPLICATION

- A. Have students explain how the techniques described below can be used to separate recyclable materials and which materials would most likely be separated with this technique:
 1. Using air
 2. Using magnets
 3. Using water
 4. Using a size-sorting device
- B. Encourage students to come up with one more way that recyclables could be separated from each other.

FIELD TRIP

If you have a materials recovery facility in your community, schedule a field trip for students to observe this facility. If a field trip is not possible, consider showing students a video clip on a materials recovery facility (see “Resources”).

EXTENSIONS

- A. Judge the designs for separating recyclable materials made in this lesson, based on

energy efficiency. Students can create a scale of energy required to use the various pieces of equipment. The winner is the team using the least amount of energy.

- B. Have students design a size sorter (e.g., a cardboard box at least one foot by one foot with two-inch square holes cut in the bottom and another cardboard box with flaps removed but without holes). Have them test these sorters.

RESOURCES

Videos

Recycling: Waste into Wealth. Oley, Pa.: Bullfrog Films, 1984 (29 minutes). Grades five through adult.

This video describes recycling techniques, including curbside pick-up services, drop-off recycling centers, materials recovery facilities, and processing into new products.

The Rotten Truth. 3-2-1 Contact Extra series, produced by Children’s Television Workshop, 1990 (30 minutes). Pleasantville, N.Y.: Sunburst Communications, distributor.

Stephanie visits a landfill and explains the problems created by the solid waste we generate. Discusses some options of waste management.

Books

Gibbons, Gail. *Recycle! A Handbook for Kids.* New York: Little, Brown & Company, 1992.

Colored illustrations and simple text describe how and what to recycle. Also explains how paper, glass, aluminum, and plastic are recycled.

Jacobs, Francine. *Follow That Trash! All About Recycling.* New York: Grosset and Dunlap, 1996.

Although written for grades one through three, this book contains illustrations and descriptions on how waste is separated at a materials recovery facility.

Websites

See “Appendix F–V, Recycling websites.”

ACTIVITY CARDS FOR THE STATIONS

1. Size Station: Use a ruler to measure and then sort the five objects from largest to smallest. Write down the order of the objects from largest to smallest.

2. Weigh Station: Use a weight scale or balance beam to weigh each object. Then write down the name and weight of each object.

3. Magnetism Station: Use a magnet to determine which items are magnetic and which are not magnetic. Record what you have found.

4. Sinkers and Floaters Station: Test each item to see whether it floats or sinks in the container of water. Record your findings.

5. Shredding Station: Use scissors to cut the different items. Record your results.

Names: _____ Date: _____

SORTING SHEET

1. Size Station:

	Length and width of item
• The largest item was _____	
• The second largest item was _____	
• The third largest item was _____	
• The fourth largest item was _____	
• The fifth largest item was _____	
• The smallest item was _____	

2. Weigh Station: Weigh each object and write down the name and weight of each of the six objects.

Object		Weight
1.		
2.		
3.		
4.		
5.		
6.		

Which object is heaviest? _____

Which object is lightest? _____

3. Magnetism Station:

These items are magnetic:

These items are not magnetic:

4. Sinkers and Floaters Station:

These items sink:

These items float:

5. Shredding Station:

These items cut easily:

These items are difficult to cut:

PROPERTIES OF RECYCLABLE ITEMS

Waste item	Properties				
	Size	Weight	Magnetic yes or no	Sinks or floats	Shredable yes or no
1. Aluminum can					
2. Tin can					
3. Piece of paper					
4. Plastic 2-liter soda bottle					
5. Polystyrene (e.g., foamed plastic cup)					
6. Orange or banana peel					
7.					
8.					
9.					
10.					

BACKGROUND INFORMATION FOR THE TEACHER

Many communities have curbside recycling. In some communities the recyclable materials are separated at home (at the source) and placed in separate containers (e.g., one container for glass, one for aluminum) or prepared in a specific way (e.g., newspapers are bundled and tied). These recyclables are set out on the curb during trash pickup days. In other communities all recyclables are placed together in one container and all other garbage in another container (i.e., garbage can) for curbside pickup. In some communities people do not sort their garbage at home. They place all types of waste in one can.

Recyclables that have not been separated at the source are often separated from each other (and sometimes from other nonrecyclable waste) at a materials recovery facility (MRF) (pronounced “Merf”), where they are sorted by machines and by people. Each MRF is designed differently. Some use mechanical means to separate recyclables, such as magnets to separate iron and steel from nonferrous metals. Other MRFs have people separating the waste. Still other facilities use both mechanical and manual means to separate the waste. The recyclable materials are usually cleaned, and those materials that can be compressed (e.g., paper and plastics) are baled before being transported to reprocessors. Materials that cannot be compressed, such as glass and

steel, are loaded into trucks for transporting to processing plants.

“Hi-tech” separation facilities are very expensive and prone to mechanical failure. But they include machines that move recyclables through tunnels that use air to separate paper and other light materials. They might also have machines that separate heavy substances, such as glass, by weight. Many MRFs also have machines that shred certain recyclables.

“Low-tech” facilities can also be efficient and provide jobs for people. At these facilities people sort through mixed recyclables by hand, pulling out paper, ferrous metals, aluminum, plastic, glass, and other recyclables. Many MRFs use both people and machines. Additional information on MRFs is provided in “Appendix B–III, Recycling.”

Understanding the physical properties of materials will help students to appreciate the ease or difficulty with which each can be reused, recycled, or disposed. This activity addresses the ways that large amounts of materials can be separated from each other for recycling or other alternatives.